Center Innovation Fund: SSC CIF

Testing for Nuclear Thermal Propulsion Systems: Identification of Technologies for Effluent Treatment in Test Facilities

Completed Technology Project (2013 - 2014)

Project Introduction

Key steps to ensure identification of relevant effluent treatment technologies for Nuclear Thermal Propulsion (NTP) testing include the following. 1. Review of Historical NTP Recommendations: As noted previously, past effort has been devoted to the requirements for NTP test effluent treatment systems. Seminal papers in this field should be reviewed and used to establish a baseline for effluent treatment approaches. 2. Review of Effluent Treatment Approaches in Related Fields: A review of relevant literature as produced for other radioactive effluent treatment applications should be conducted. For example, Department of Energy(DOE) systems used for the treatment of nuclear waste are primary targets for this literature review. Personal communication with DOE subject-area experts can also be established as part of this review. 3. Assessment of Current Status for NTP Reactors/Engines: An assessment of the types of NTP reactor systems currently under consideration for future development should be performed. A variety of reactor, engine, and fuel component designs have been proposed in the past. The effluent treatment system will be strongly impacted by the expected effluent as determined by the types of reactors under consideration, as some reactor types are expected to produce less particulate or other radioactive material emissions. This assessment can be performed through literature searches and via communication with programmatic leadership and subject area experts for the NASA NTP program. 4. Assessment of Recent Developments in Effluent Treatment: Contact with commercial vendors and contractors for effluent treatment should be established in an attempt to identify the most current developments relevant for NTP testing. 5. Review of Expected Chemical Effluents: While the radioactive nature of the effluent stream from an NTP test is of primary concern, chemical reactions will also be initiated in the hot hydrogen exhaust prior, during, and after the effluent treatment. The chemical kinetics expected in this environment is a relevant topic for investigation and literature should be reviewed for anticipated chemical effluent 6. Identification of Key Instrumentation: Instrumentation needed to support NTP testing and provide feedback for facility operational health and environmental safety will be significantly different for nuclear engine testing than for chemical propellant engines. A review of literature recommendations and updated analysis for newly available instrumentation is needed

Develop a comprehensive understanding of requirements for a facility that could safely conduct effluent treatment for a Nuclear Thermal Propulsion (NTP) rocket engine system. Methodology options that could be implemented for NTP effluent treatment are being compiled and evaluated. NTP effluent treatment is necessary to ensure compliance with environmental and safety standards associated with any potential release of radioactive species. The types of rocket engines reactors and fuel elements under consideration will affect the effluents mitigation technologies and the monitoring capabilities that could ultimately be utilized for an NTP rocket engine testing facility. Therefore,

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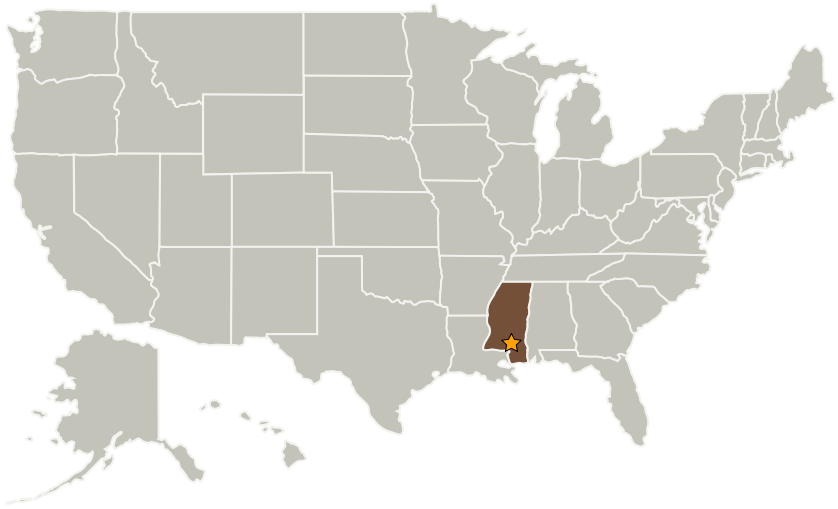
an extensive understanding of the current state-of-the-art related to effluent technologies is required, which includes exploring innovative effluent treatment options, so that the safest and most optimal decision making can be recommended for an NTP ground testing system facility. Review of such systems and consideration of other recent developments in offgas treatment should be conducted in support of planning for future NTP testing activities.

Anticipated Benefits

This compendium of information on NTP effluent treatment options positions NASA to be optimally prepared to address the requirements of testing facilities that meet current safety standards, and these facilities must provide effluent treatment systems. The development of NTP systems and ground test facilities is increasing rapidly with the release of recent NASA reports. The drivers for this renewed interest are the significant advantages offered by NTP-based systems as in-space transportation for manned missions to Mars and Near-Earth Asteroids (NEAs). For example, in considering nuclear thermal rocket (NTR) technology, the Human Exploration of Mars Design Reference Architecture 5.0 (DRA 5.0) states that: The DRA 5.0 report recognizes NTP as a proven technology.

Primary U.S. Work Locations and Key Partners



Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Stennis Space Center (SSC)

Responsible Program:

Center Innovation Fund: SSC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

Ramona E Travis

Project Manager:

Lauren W Underwood

Principal Investigator:

Lauren W Underwood

Co-Investigator:

Christopher Winstead

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Organizations Performing Work	Role	Type	Location
★Stennis Space Center(SSC)	Lead Organization	NASA Center	Stennis Space Center, Mississippi
University of Southern Mississippi	Supporting Organization	Academia	Hattiesburg, Mississippi

Primary U.S. Work Locations
Mississippi

Images

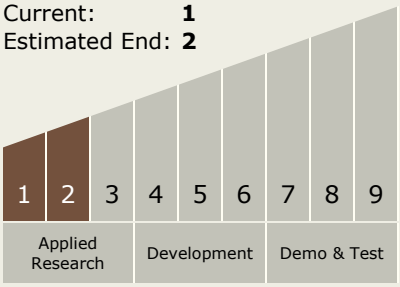
University of Southern Mississippi
University of Southern Mississippi
(https://techport.nasa.gov/image/2778)

Stories

Testing for Nuclear Thermal Propulsion Systems: Identification of Technologies for Effluent Treatment in Test Facilities Project
(https://techport.nasa.gov/file/3503)

Technology Maturity (TRL)

Start: **1**
Current: **1**
Estimated End: **2**



Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.4 Advanced Propulsion
    - TX01.4.3 Nuclear Thermal Propulsion